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Breeding for Resilient, Efficient and Sustainable Organic Vegetable production

Deliverable No. D5.1

Comprehensive list of varieties per crop and location to be grown on-farm along with fact sheets concerning their growing, harvesting and taste characteristics

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1 List of Abbreviations

AMW Average Marketable (fruit) weight BER Blossom End Rot CMS Cytoplasmic Male Sterility F1 First generation hybrid **GenRes Genetic Resources** GH Greenhouse Nct Not chemically treated Open field OF OP Open pollinated Q (marketable) Quality TYLC Tomato yellow Leaf Curl virus

2 Introduction

The first two objectives of WP5 are i) to evaluate a shortlist of breeding lines compatible with organic farming for the production of crops of enhanced quality and marketing value and ii) to provide farmers with new materials to be tested alongside commercial organic varieties on farm. In this report, we describe the evaluation and selection process of the varieties that will be commonly tested in multiple locations and list the additional varieties that will be included locally in each trial. We also give the characteristics of the cultivation of each of the 3 crops at each participant's location.

3 Description of Activities

From the start of BRESOV, it became quickly clear that elite breeding lines of the project which are collected from gene banks, will not have the seed quantity needed for multi-location on-farm trials carried under the usual production farm practices nor for a sufficient multiplication within the first 2 years of the project. Therefore, additional material fulfilling the requirements of organic farming has been added to the breeding set. P6-FiBL scouted for these additional breeding lines and varieties from organic seed producers, mainly Sativa Rheinau AG, Kultursaat e. V. and CULINARIS - Saatugut für Lebensmittel.

Partners P17-PSR assisted in this first selection. P11-VRDS, P9-UNILIV and P1-UNICT also procured additional material: 2 tomato varieties, 1 broccoli variety and one broccoli landrace, respectively. The scouted material consists of a majority of advanced lines on which breeders and seed producers are working, and which have previously demonstrated some of the desired characteristics for cultivation under organic agriculture and under biotic and abiotic stress conditions. These lines have enough seeds available for a timely propagation during the project and were therefore added to the BRESOV breeding set. Testing these varieties under the usual production practices on-farm will gives us and the farmers a real insight of the potential of new material or not highly exploited varieties. The selection of the main trial varieties as well as the local references varieties at each location are part of the activities of Task 5.1. Additional lines resulting from the phenotypic activities of the other WPs are added in certain locations depending on seed availability.

We describe below the selection process of the common varieties of each broccoli, tomato and beans.

3.1 Selection of broccoli for multi-location trials

While the project tackles several brassica subspecies, we decided to focus on broccoli in this task. This allows us to base the selection on more material than if we would have included other Brassica subspecies and therefore have a better chance of identifying promising material for at least one crop type. We assembled a total of 9 broccoli lines (Table 1). Some of these lines have been tested in previous projects of P6-FiBL and have demonstrated a certain potential. These are for the majority advanced breeding lines. Using these varieties, P18-ITAKA and P6-FiBL carried a trial each, in Italy during autumn 2018 and in Switzerland during spring 2019, respectively. The trials were performed with two repetitions per variety, under usual production conditions at each location and fertilized according to usual practices. P18-ITAKA used for their trial the reference variety Covina F1 and P6-FiBL used the variety references Covina F1 and Batavia F1. These 2 varieties are come from a CMS (Cytoplasmic male sterility) -free selection and are quite commonly used in organic broccoli cultivation. Batavia F1 was not included in the Italian trial as it is a variety which grows well in warmer conditions and is rather adapted for a spring-summer, rather than fall-winter cultivations as it was the case in Italy. Covina F1 on the other hand is suitable to both cultivation periods and was therefore used as reference in both the Swiss and Italian trials.

FiBL label	. label Name FiBL label		Name		
FiBL 1	SAT 31	FiBL 6	KSV-BRO-TH-LIM19/28		
FiBL 2	FiBL 2 SAT 30 FiBL 7		KSV-BRO-TH-LIM20/68		
FiBL 3	Ramoso Calabrese	FiBL 8	KSV-BRO-TH-LIM37/59		
FiBL 4	Rasmus	FiBL 9	CN-Bro-09 (nct)		
FiBL 5	KSV-BRO-CHE-BALB				

Table 1: Broccoli lines/varieties used in Italian and Swiss trials for the agronomic and organoleptic evaluation and the selection of the best material for the multi-location on-farm cultivations.

At each harvest date, yield data were collected and a visual assessment of colour, shape, regularity, length of branching and size of buds for each variety was performed.



Figure 1: Transplantation of broccoli (left) and cultivation (right) at Agrico, CH.

In a second step, the best performing varieties in the evaluation were then selected for an organoleptic assessment. To these were added the varieties FiBL1 SAT 31, FiBL2 SAT 30 and FiBL6 KSV-BRO-TH-LIM19/28 based on results from previous projects or known characteristics. An untrained tasting of the Italian production took place at P1-UNICT on 12.03.2019, and one for the Swiss production on the 14.06.2019 at P6-FiBL.

During August 2019, an organoleptic-assessment took place at P6-FIBL in two parts: a training session and the actual organoleptic evaluation. The first session aimed to train the group at recognizing and scaling the different tastes which are relevant to broccoli. The concept of this training was developed by P6-FIBL and P17-PSR. The first step was to attribute a certain taste characteristic to different kind of food, and different cooking ways and to order food by category and intensity of the taste property. In a second step, the jury tasted different commercial broccoli, established the list of main identifiable properties and scaled them. During the second session, the different varieties of broccoli were tasted, compared to the reference, and evaluated for each property.

The varieties were presented using numbers to keep the evaluation blind. Each participant tasted the varieties in a different random order. The attributes to be evaluated were selected based on the list found in the DIVERSIFOOD sensory guide and the results of the training session. The assessment was therefore done with the following attributes and using a scale from 1 to 5, 1 meaning "not present" and 5 "very strong".

Odour	Taste	Texture	Appearance
			colour (green,
Weed-like	Cooked cabbage	Spongy	brown)
Cooked cabbage	Nutty	Tender	compactness
Earthy	Sweetness	Fibrous	
	Bitter	Squeaky	
	Buttery		
	Grassy –hay		
	Acid		
	Salty		

3.2 Selection of tomato for multi-location trials

7 greenhouse (GH) indeterminate varieties and 5 open field (OF) determinate varieties were assembled (Table 2). P21-SECL cultivated the greenhouse (GH) varieties (i.e. FiBL-T5.1-FiBL-T5.1-7) as well as the two open field (OF) varieties provided by P11-VRDS (FiBL-T5.1-11&12) in spring-summer 2019 to make an agronomic evaluation and produce the tomato for the organoleptic assessment. P18-ITAKA cultivated all varieties for agronomic evaluation, seed multiplication and production of tomato for organoleptic assessment.

FiBL Label	Name	Breeder/ provider	Type/description	
FiBL T5.1 - 1	332 beafsteak tomato	<u>Culanaris</u>	beafsteak tomato, field resistance against Phytophthora infestans, selected in low-input condition, expect (and partially know) tolerance to drought and reduced nutrient supply.	GH
FiBL T5.1 - 2	298-x	<u>Culanaris</u>	salad tomato with special flavour, field resistance against Phytophthora infestans, selected in low- input condition, expect (and partially know) tolerance to drought and reduced nutrient supply.	GH
FiBL T5.1 - 3	236-x	<u>Culanaris</u>	small salad tomato with special flavor, selected in low-input condition, expect (and partially know) tolerance to drought and reduced nutrient supply.	GH
FiBL T5.1 - 4	tz32 - Coeur de boeuf Albenga pink	<u>Sativa</u> Rheinau	oxheart /beafsteak typ, indederminate	GH
FiBL T5.1 - 5	tz30 - Coeur de boeuf Albenga	<u>Sativa</u> Rheinau	oxheart /beafsteak typ, indederminate	GH
FiBL T5.1 - 6	tz22 - Coeur de boeuf	<u>Sativa</u> Rheinau	oxheart /beafsteak typ, indederminate	GH
FiBL T5.1 - 7	tz24 - Coeur de boeuf Pescarese	<u>Sativa</u> Rheinau	oxheart /beafsteak typ, indederminate	GH
FiBL T5.1 - 8	To65 - Mauro Rosso	<u>Sativa</u> Rheinau	San-Marzano like Type , determinate growth for outdoor / processing	OF
FiBL T5.1 - 9	Tz-sat02- Sativa Industrie 2	<u>Sativa</u> Rheinau	San-Marzano like Type , determinate growth for outdoor / processing	OF
FiBL T5.1 - 10	Tz-sat03- Sativa Industrie 3	<u>Sativa</u> Rheinau	San-Marzano like Type , determinate growth for outdoor / processing	OF
FiBL T5.1 - 11	L – 15 Bacau	C. Brezeanu VRDS [Ro]	Open field, fresh market, processing; Determinate, 50-70 cm plant height; In our environmental condition (Bacau) Mosaic Virus & Alternaria were not signaled; Days to maturity 130 – 135 (from emerge to first harvest); yield 100-110 t/ha; medium weight of the fruit 110-170 g; shape of fruit spherical – flattened	OF
FiBL T5.1 - 12	PL 10 Bacău	C. Brezeanu VRDS [Ro]	Open field, fresh market, processing; Determinate, 60-75 cm plant height; In our environmental condition (Bacau) Mosaic Virus & Alternaria were not signaled; Days to maturity 130 – 135 (from emerge to first baryest), yield 60-80 t/har medium weight of the fruit 80-100 g; shape of fruit round	OF

Table 2: List of tomato candidates procured for the selection of the greenhouse (GH) and open field (OF) material for the trials of T5.2

In both French and Italian trials, FiBL-11 – L15 Bacau did not germinate and was therefore excluded. The trial of P18-ITAKA started in June 2019 and included two standard references Bacio F1 – cherry and Piccadilly F1-plum. All 13 varieties were transplanted under a greenhouse in July. Despite cultivation being done in a standard location and under normal conditions for tomato production, we couldn't prevent an incidence of TYLCV (Tomato yellow leaf curl virus). This was triggered by extremely high temperatures and resulted with the end of the trial. The evaluation of the GH varieties was therefore only based on P21-SECL's trial and for the OF tomato, all 4 varieties were kept to be tested in the different on-farm locations of T5.2.

P21-SECL evaluated the 7 GH genotypes and FiBL12-Pl10 Bacau for their agronomic value under a plastic greenhouse and in organic production for a seasonal harvest from July to September 2019. P21-SECL is part of an organisation that routinely makes the evaluation of varieties in Brittany for the selection of the best new varieties to be used by farmers. Currently, their selection standards are very high and almost similar to the standards required in conventional agriculture. They also have their own variety testing procedures and data collection tables. They evaluated the agronomic potential, the characteristics of the plants and the commercial value of the values using Codino as a reference. The reference variety had to be cultivated in an adjacent cell, part of another tomato trial of BRESOV on rootstock because of the lack of space for an additional variety in the trial cell.

At two points during the harvest, P21-SECL sent fruits to P8-VEG, who performed the organoleptic assessment of these varieties. P8-VEG measured dry matter, Brix degree and titratable acidity of fruits and trained panellists to recognize and quantify 10 criteria describing odour, taste, flavour and texture of tomato and therefore characterize the set of tomato varieties. In addition, P8-VEG participated in a one-day tasting event "les Chants de Marins" (Paimpol, Brittany, France) in August 2019. There, the eight greenhouse tomato varieties were proposed to consumers for a public evaluation during this event. The tasters were asked to score the varieties according to their appreciation, by tasting at least three tomatoes or more if they wanted. 356 consumers participated and each variety was evaluated at least 204 times.

P8-VEG could not evaluate open field tomato varieties as planned because the trial of P18-ITAKA failed and therefore no tomatoes were provided.

3.3 Selection of beans for multi-location trials

Among the 34 bean accessions added by P6-FiBL and P11-PSR to the breeding set, 10 lines with promising characteristics and feedback from the breeders have been selected and cultivated in a variety trial performed by P6-FiBL on-farm in Ellikon, Switzerland. The trial consisted of the 10 varieties of table 3 and the standard variety Maxi which was used in two ways: directly sown and transplanted. Prior to sowing, all seeds were treated with warm water (cf. D6.6 Practice abstract on bean treatment) which is a usual practice locally.

Variety		Seed		Origin	Pod	
label	Variety name	color	Туре	(Country)	color	Notes
	Blaue Kronbacher	light	breeding	Kultursaat	purple	
1		brown	line	e.V. (DE)		
	KSV-BB-RH-G78	white	breeding	Kultursaat	green	
2			line	e.V. (DE)		
	Marché de Vully			ProSpecieRar		
3		red	landraces	a (CH)	green	tender, robust, Swiss selection
	Roi des Beurres					
	/Kinghorn			ProSpecieRar		wax bean type, good flavor and delicious
4	wax/Boterkoning	white	commercial	a (CH)	yellow	mouthfeel
	Fin de Bagnols	red w/		ProSpecieRar		
5		spots	commercial	a (CH)	green	early ripening, fine pods
	La Victoire			Sativa		
6		black	commercial	Rheinau (CH)	green	early ripening, robust
	Odessa			Sativa		
7	(Wunderfein)	white	commercial	Rheinau (CH)	green	very fine pods, intense flavor
	Saxa			Sativa		
8		beige	commercial	Rheinau (CH)	green	good taste, robus
	Slenderwax			Sativa		
9		white	commercial	Rheinau (CH)	yellow	wax bean type, thick pods
	Wunderfein			Zollinger		
10	Selektion Z	white	commercial	Samen (CH)	green	very fine pods, very intense flavor
	Maxi (sown)			Sativa		
11		old pink	commercial	Rheinau (CH)	green	
	Maxi (planted)			Sativa	-	
12		old pink	commercial	Rheinau (CH)	green	

Table 3: List of varieties cultivated b	v P6-FiBL	for the selection	of material for T5.2
	,		of material for for

The last harvest of P6-FiBL's snap beans variety trial was carried at the end of September. At the start of the harvest, width, height and density of the plants from each variety were assessed. At most harvest dates, a visual evaluation of disease, an assessment of plant stability (i.e. ability to remain standing without support), and a measurement of harvest duration per plot were performed. Pods were weighted and counted, and unmarketable pods removed, weighted and the reason of rejection was recorded. In general, the quantity of rejects was minimal in all varieties.

Following a similar procedure like for broccoli, P6-FiBL and P17-PSR made a semi-trained organoleptic assessment of the 6 best performing varieties in the trial.

3.4 Selection of additional genetic material per location

For each of the three crops, P6-FiBL provides the seeds of the best varieties (2 for each of bean and broccoli, 4 for each of GH and OF tomato; outcome of the trials described in 2.1, 2.2 and 2.3) to the partners for the multi- locations on-farm trials. In addition to this common material, each partners involved in the on-farm trials of T5.2 selects for each of the crop they will be cultivating a third variety to include in the test, in some cases more than one.

The selection procedure is carried by partners and can be done by i) performing a variety trial and assessing agronomic and/or organoleptic quality (such as done by P11-VRDS), ii) a public tasting of several candidates at an exhibition or event, and iii) a tasting by an untrained panel (such as done by P12-CREA).

During the first project period, P6-FiBL provided all partners of T5.2 with instructions and a degustation evaluation sheet specific to each crop. Some of the partners used it to choose a local variety (or varieties) to add to their on-farm trial. Some partners performed field variety trials and some used events to do public tastings of several varieties. In some cases, partners decided to include in the on-farm trial a standard reference such as the variety which is often used or largely appreciated in their regional organic production. In addition to these varieties, and following the advice of the project officer, lines tested by partners within WP2 and WP3 were added to the list of varieties in certain on-farm locations, whenever enough seeds were available. Lines which became available only later where added in the trials of the second year (e.g. added tomato lines from the breeding set).

Below are the activities of some of WP5 partners regarding the selection of additional material:

P11-VRDS screened 12 GenRes for bean, 10 for tomato and 5 broccoli cultivars. Bean and tomato material were collected in local farms or in different phases of variety development. Earliness, suitability to organic cultivation (resistance to biotic stress), productivity and organoleptic appreciation were the criteria for selection. Products were also tasted according to the protocol provided by P6-FiBL. P11-VRDS obtained nice candidates that will be included in their local on-farm trial next to the common material.

P4-UTAD organized a one day tasting event in November 2019 where consumers tasted three varieties and filled the common evaluation questionnaire provided by P6-FiBL. The broccoli for this evaluation were from the three commercial varieties Malibu, Marathon and Parthenon which were cultivated by P4-UTAD for this purpose.

In August 2019, P12-CREA made a selection of 8 tomato accessions from all the material (Core Collection and Breeding Set) cultivated at CREA Monsampolo del Tronto within WP2. The selection was based on a visual assessment of parameters such as health, vigour, fruit set, fruit colour and fruit size. An organoleptic panel test attended by 24 tasters of which 7 consumers, 5 agricultural technicians and 3 researchers was performed following the criteria shared among partners.

P14-ZAAS performed trials including 3 varieties of tomato, 3 varieties of common bean and 2 varieties of broccoli on- farm under regular organic production methods in 2018, as a pre-test.

Other partners selected varieties which were well adapted to their local agro-climatic conditions with local breeders' or farmers' feedback.

3.5 Crop cultivation conditions at each location

During the first period of BRESOV, P6-FiBL collected from each partner, the usual organic cultivation conditions of the 3 crops in their locations, known as BAU (business as usual). This information is the basis for the calculation of seeds needed at every location, the timing of their procurement, and the parameters to design the on-farm trial of T5.2. The choice of crops cultivated by each partner depended on their research expertise and/or crop specialisation.

4 Results

4.1 Selection of broccoli for multi-location trials

The first results of the Swiss trial (see figure 1) showed that three varieties, namely the FIBL4 Rasmus, FiBL5 KSV-BRO-CHE-BALB and FIBL9 CN-Bro-09, produced a good yield in comparison to the standard varieties Covina F1 and Batavia F1. Batavia produced the highest brut yield with 66 kg/are, followed by FIBL 9 CN-Bro-09 (55 kg/are), FiBL5_KSV-BRO-CHE-BALB (49 kg/are), FIBL 4 Rasmus (46 kg/are) and Covina (41 kg/are). Figure 1 also shows the rate of rejected heads per variety, with FiBL1 - SAT 31, FiBL2 - SAT 30, FiBL3 - Ramoso Calabrese, FiBL6 - KSV-BRO-TH-LIM19/28 and FiBL7 - KSV-BRO-TH-LIM20/68 obtaining a high percentage of rejected heads in addition to their low yield.



Figure 1: Yield per variety in Kg/are in Switzerland, at Agrico location. The dots indicate the proportion of rejects in the production.

Figure 2 shows for each variety and per are the total number of heads produced, the number of heads marketable in first quality, in second quality as well as the rejects. FIBL4 Rasmus obtained the second highest production of marketable head in first quality per are (167 heads/are), just after the standard variety Batavia (267 heads/are). The varieties FiBL5 KSV-BRO-CHE-BALB and FIBL9 CN-Bro-09 also obtained a good production of 1st quality marketable heads, 127 heads/are and 120 heads/are, respectively. FIBL4 Rasmus outperformed the standard variety Covina which obtained 133 heads/are. The standard F1 varieties Batavia and Covina obtained the lowest rate of rejected heads (4% and 21%), followed by FIBL9 CN-BRO-09 (18%), FiBL5 KSV-BRO-CHE-BALB (37%) and FIBL4 Rasmus (31%).

The other varieties had quite a low production and the heads of the varieties FiBL1 SAT 31, FIBL2 SAT 30 were often (>50%) small, irregular or had open flowers, all reasons for market rejection.

The variety FIBL3 Ramoso Calabrese scored at the lowest in the Swiss trial, with almost no yield and a very high rate of rejected heads. The variety produced a lot of vegetative biomass (leaves) but barely any heads.



Figure 2: Number of marketable head per are in first class quality of each variety in the Swiss trial

We observed similar yield tendencies in the Italian trial carried by P18-ITAKA. FIBL4, FIBL5 and FIBL9 were among the best producing varieties. In this trial however, it is FIBL2 SAT30 which obtained the highest yield in terms of total weight of heads harvested (figure 3).



Figure 3: Total weights of heads harvested in Italy for the first and second commercial quality as well as the rejects.

The data collected from the visual assessment done by P6-FIBL and P18-Itaka showed that the standard variety Batavia F1, as well as FiBL4 Rasmus presented the best shape according to the standards for broccoli. In Switzerland, the variety FIBL6 KSV-BRO-TH-LIM19/28 also showed a satisfying shape (value: 2.0) but not in Italy (value: 3.0; figure 4). The two standard variety Batavia and Covina obtained the most regular heads shape in the Swiss trial, followed by FIBL6 KSV-BRO-TH-LIM19/28, FiBL5 KSV-BRO-

CHE-BALB and FIBL3 Ramoso Calabrese (figure 5). The results for FiBL3 Ramoso calabrese were excluded as heads were too small and not marketable. The visual assessment carried by P18-Itaka more or less confirms the results obtained by P6-FiBL.



Figure 4 & 5: Shape and regularity evaluation on the Italian trial (left column, in blue) and the Swiss trial (right column, in grey).

The varieties FIBL9 CN-Bro-09 and FiBL4 Rasmus obtained very good results regarding the length of the branch. They were the two best varieties right after the standards Covina and Batavia. In the Italian trial, the variety FiBL5 KSV-BRO-CHE-BALB also showed short branching (figure 6).





Size of buds did not significantly differ between the varieties in the Swiss trial.

As a conclusion to the agronomic assessment of broccoli, we can say that the open-pollinated (OP) varieties **FIBL4 Rasmus**, **FiBL5 KSV-BRO-CHE-BALB and FIBL9 CN-BRO-09 led to better results than the other open-pollinated varieties**. Furthermore, FIBL4 Rasmus scored high on the production of first quality heads, with good shape and short branches, as well as a low rate of rejected heads. These three varieties were then selected for the organoleptic assessment. In addition, and based on previous results or known characteristics, the varieties FiBL1 SAT 31, FiBL2 SAT 30 (highest yield in the Italian trial) and FiBL6 KSV-BRO-TH-LIM19/28 were included in the organoleptic assessment even if their yield in these trials was quite low (except for FIBL2 in Italy).

At both locations, a tasting by untrained jury was carried, and in both, FiBL1-SAT31 was the preferred variety. This could be however slightly biased by the fact that in both cases, this was the first variety

tasted by the participants. In the trained organoleptic assessment at P6-FiBL, all included broccoli varieties obtained a good note for the colour. In general, participants preferred the compactness of Covina -a standard variety- to that of the other varieties. There were almost no detection of acidity, but a bit of bitterness could be tasted in FiBL5_KSV-BRO-CHE-BALB and Covina, and to a lower extent in FiBL2-SAT30 and FiBL4-Rasmus. FiBL1 Sat 31, FiBL9_CN-Bro-09 as well as the reference Batavia were judged sweeter than the others. In figure 7 are mapped the small sensory differences perceived between all varieties, with the attributes which are usually perceived as negative (acidity, bitterness, fibrousness, squeakiness, sponginess) on the right, and those usually positively perceived (tenderness, nuttiness, sweetness, butter) on the left. Lines in red shades refer to varieties with low agronomic potential, lines in green to varieties with agronomic potential and the two blue lines refer to the standard varieties Batavia and Covina.



Figure 9 Radar chart for the organoleptic assessment of broccoli

There were only little differences perceived between the varieties. The expressed preferences of the group for either one or the other variety is most probably linked with the positive attributes.

At the end of the degustation, tasters indicated their favourite varieties. The reference Batavia and Covina obtained the highest number of votes. Followed by FiBI1-SAT31, similarly to the result of the untrained tasting. FiBL4-Rasmus and FiBL-9-CN-BRO-09 which demonstrated good agronomic performance as well as FiBL6-KSB-BRO-TH-LIM19/28 obtained one vote each.

These results are compatible with the conclusion we came to during the different tastings and training: **unlike other crops such as tomato, the sensory relation to broccoli (taste, smell and looks) is not a determining factor when selecting a variety.** The selection of the best varieties for breeding or cultivation should be rather based – for broccoli – on other traits then those of taste.

As a conclusion to these trials with broccoli, P6-FiBL recommends to use FiBL4-Rasmus (general good yield, high rate of first quality heads and low rate of rejected heads) and FiBL9-CN-BRO-09 (one of the best production rates, shape similar to the reference varieties), which were also supported by a good organoleptic assessment as the commonly tested varieties in the trials planned for T5.2.

4.2 Selection of tomato for multi-location trials

L

P21-SECL evaluates tomato varieties routinely in Brittany according to a strict "cahier de charges", where selection standards are very high and almost similar to the standards required in conventional agriculture. P21-SECL evaluated the tomato lines according to their usual scoring and comparing them to the variety Codino as a reference.

The results of the production in table 4, with the brut yield, net yield, the average commercial weigh, number of fruits, percentage of rejects as well percentage of fruits per marketable quality.

	Total yield	Fruits/		Waste				Marketable			
	[kg/m ²]	plant	AMW [g]	[g/m²]	% Waste	BER [g/m ²]	% BER	yield [kg/m²]	% Q1	% Q2	% Rejects
Tz 24 - Fibl T5.1-7	16.0	19.0	255	996	7.9	2824	18.9	12.1	16	57	27
332 - Fibl T5.1 - 1	15.0	22.7	230	1935	13.8	0	0.0	13.0	27	44	29
Tz 30 - Fibl T5.1 -5	16.7	36.8	163	1615	10.5	141	0.9	14.9	24	34	42
Tz 32 - Fibl T5.1- 4	14.8	48.8	113	692	4.8	277	2.1	13.8	90	10	0
236 x - Fibl 5.1 - 3	8.9	88.8	38	517	6.1	0	0.0	8.4	89	11	0
Tz 22 - Fibl 5.1 - 6	15.7	34.3	144	1118	8.5	2228	15.6	12.3	76	24	0
298 X - Fibl 5.1 - 2	9.9	117.9	33	115	1.1	0	0.0	9.7	92	8	0
PL 10 Bacau - Fibl T5.1 - 8	8.6	21.7	153	400	4.1	0	0.0	8.2	22	32	46
Reference (Codino grafted 2019)	38.9	105.5	131	538	1.4	0	0.0	38.4	84	16	0
Reference (Codino non-grafted 2020)	21.7	71.3	119	1606	7.6	445	2.4	19.7	76	24	0

Table 4: The results of the agronomical assessment carried by P21-SECL in France. AMW =average marketable fruit weight,

 BER = Blossom End Rot. Q1 are first quality fruits which are similar to those of established commercial varieties.



Figure linked to Table 4: Total yield, Q1, Q2 and rejected yield. The values for Codino, a standard reference of P21-SECL, come from a different trial and are drafted in 2019, or not drafted as in 2020.

Tz30, Tz32, 332 and Tz22 (followed by Tz24) obtained the highest marketable yield in Kg (Table 4 & linked figure). 236x and 298x were among the lowest in yield, with fruits weighing on average less than 40g. According to their usual variety evaluations, P21-SECL concluded the following:

- TZ 24 has no special interesting features, is sensitive to BER (Blossom End Rot) and has yellow collars.
- 332 is of little interest due to its high percentage of waste and its fruit quality.
- TZ 30 has very heterogeneous fruit quality and might not be interesting.
- TZ 32 produces a very nice set with a beautiful brilliant colour, but nevertheless lacks firmness. This characteristic might make it sensitive to transport.
- 236 X fruits are too large for the cherry type and sensitive to bursting.
- TZ 22 produces a nice set but lacks of homogeneity of form and firmness.
- 298 X produces also a very nice set but its fruits are a little big for the cherry type.

• PL 10 BACAU as a determinate variety is not interesting for greenhouse cultivation and produces fruits of average quality. PL 10 is to be evaluated again among the other determinate varieties of the collection.

Varieties with low interest to cooperatives applying standards close to those of conventional agriculture in Brittany could be nevertheless interesting to independent organic farmers, especially those selling their products without an intermediary i.e. direct farm marketing. This model is currently very successful due to the boom in vegetable farms distributing weekly baskets directly to their subscribed customers. We also expect changes in the consumer attitudes in order to accept different standards which are more compatible with the low input, difficult climatic conditions and organic agriculture. To conclude and based on the agronomic evaluation, as recommended by P21-SECL, **TZ32**, **TZ22 and potentially 298X are the best varieties.**

P8-VEG analysed the fruits of P21-SECL harvest, had them assessed by a trained jury and presented them for a public tasting during to an event. They used the variety "Prune d'Antan" as taste reference. With the results obtained, P8-VEG gave the following assessment per variety and produced sensory maps for each one of them.

236-X Preferred by consumers: 56% are satisfied (score >6) and only 14% scored it und acceptability limit. Comments of consumers deal with taste (sweet and acid), so was too sweet or too acid. Thickness of the skin and its hardness was also ment The trained panel characterized 236-X as juicy, sweet, acid, tomato flavour, th aromatic intensity and less mealy. It obtained the highest dry matter, Brix deg titratable acidity.	er 5, the me say it ioned. nick skin, gree and
298-X Also appreciated by consumers but less than 236-X: 48% are satisfied (score:	>6), 25%
scored it under 5, the acceptability limit. Most of the comments concerned the l	nardness
or thickness of the skin.	
According to the trained panel, it is crunchy, acid, thick skin, little juicy and	not very
mealy. Its tomato flavour is rather intense, and it is not very melty.	
Its dry matter and brix degree and titratable acidity are closed to those of 298-x	although
a little bit lower.	
332 332 is the less appreciated by consumers: half of them scored its between 4 an	d 6. 37%
give it a score under the acceptability limit (5). Most of the comments deal wit	h its lack
of taste.	
of taste. For the trained panel, 332 is juicy, melty, little sweet and has not a pronounced	l tomato
of taste. For the trained panel, 332 is juicy, melty, little sweet and has not a pronounced flavour. It is also not so mealy. 332 has the weaker Brix degree (4.4) and med	l tomato lium dry
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 of taste. For the trained panel, 332 is juicy, melty, little sweet and has not a pronounced flavour. It is also not so mealy. 332 has the weaker Brix degree (4.4) and med matter and titratable acidity. TZ22 Like 332, it is less appreciated. It received as many satisfied opinions as mixed 38%) and the most dissatisfied. For 37% of consumers, it is under the acceptab (5). The comments indicate that it is too watery, juicy, with a lack of taste. For the trained panel, it is melty, not sweet, not crunchy and not acid. Tomato frather weak.TZ22 has medium Brix degree (4.7), a titratable acidity and dry smaller than Prune d'Antan (respectively 6 and 5.7%) TZ24 Tz24<	d tomato dium dry (37 and ility limit davour is y matter % scored joyed its by some

	The panel however, detected a more pronounced tomato flavour, as the intensity of
	taste, it is sweet, low acid, slightly crisp, melty, and fine skin. However, its Brix degree,
	titratable acidity and dry matter are among the lowest.
TZ30	It collected mainly mixed scored (45%) of which 21% scored 5. 18% did not like it and 28%
	scored it below 5. Many regret its lack of taste while others appreciate it.
	It is juicy, slightly crunchy, not very acidic and not very mealy. Its taste is slightly sweet
	and its skin rather fine.TZ30 has higher Brix degree than TZ22 (4.9), a lower titratable
	acidity and dry matter (respectively 5 and 5.5%)
TZ32	Distribution of ratings close to those of TZ30 with mainly mixed scored, 17% are unhappy
	and 30% rated it below 5. Consumers mention its mealy texture, even firm, lack of taste,
	some highlight an atypical taste. According to trained panel, it is mealy, not melty, not
	juicy and its skin is thick. Taste is a little sweet and acid. Its Brix degree is close to that of
	TZ24 (4.6), its titratable acidity and its dry matter slightly higher (6.2 and 6%).
PL10	It was not presented to consumers, no data on appreciation is available.
Bacau	According to the trained panel, PL10 Bacau has a good tomato flavour, melty and a fairly
	thin skin. It has medium Brix degree (4.8), titratable acidity (7) and dry matter (5.9%).
Prune	Used as a reference. It is pretty well appreciated: 46% of consumers are satisfied
d'Antan	(score>6) and like 298-x, 25% scored it under acceptability limit (5). Consumers
	mentioned its colour, some of them talk about a lack of taste while other likes freshness
	and slight acidity.
	It scores medium on almost all attributes: weak tomato flavour, not very crunchy,
	moderately acid, moderately sweet, melty and medium-juicy. It has medium Brix degree
	(4.7), titratable acidity (7) and dry matter (6.1%).



Figure 10: selected sensory maps resulting from the organoleptic assessment of P8-VEG.

P8-VEG concludes that 236-X was the preferred variety followed by 298-X, Prune d'Antan (reference variety) and TZ24. 332 and TZ22 were less appreciated. TZ30 and TZ32 received appreciation rates between 298-X, Prune d'Antan, TZ24 and 332, TZ22.

Based on the agronomic and organoleptic results of P21-SECL and P8-VEG, respectively, P6-FiBL reduced the number of GH varieties in the selection to candidates to be used commonly in the multilocations on-farm trials. **298X** is selected knowing that it is resistant to *Phytophthora infestans*, has been selected under low-input conditions, and that it has shown tolerance to drought and nutriments limitation. It performed well in the tests of P21-SECL and P8-VEG. The 3 others varieties selected are: **TZ24** (good yield and taste, but little interest for Brittany), **236X** Best taste and resistance like 298X, and **TZ32** (good results in P21-SECL's evaluation, good yield and better taste than TZ22).

The choice of 298X (FiBL2), TZ24 (FiBL7), 236X (FiBL3) and TZ32 (FiBL4) was agreed on by P21-SECL and P8-VEG. P6-FiBL sent P18-ITAKA seeds from these varieties and the 4 OF varieties in order to repeat the cultivation for the evaluation of OF varieties and the seed multiplications of all 8 varieties.

4.3 Selection of bean for multi-location trials

We obtained a nice gradient of yields among the different varieties with Slenderwax and La Victoire performing best. They produced the highest total yield (Figure 11), the highest yield per plant (Figure 12) and obtained acceptable values for the ease of harvest (Figure 13) compared to the reference Maxi. The pods of Maxi are hanging above the leaves and therefore easier to see and faster to pick.



Figure 11 & 12: total yield and yield per plant of tested bean varieties (n plots=24), respectively. Error bars indicate the minimum and maximum values.



Figure 13 & 14: Respectively, ease of harvest measured in Kg harvested per hour and number of pods per plot of tested bean varieties (n plots=24). Error bars indicate the minimum and maximum value.

The 6 best performing varieties were assessed for their organoleptic qualities by P6-FiBL and P17-PSR. La Victoire reached the highest overall rating (4.8 points on 6), followed by Slenderwax and Saxa (both 4.6, see Figure 15). Differences between varieties were very subtle and not significant.



Figure 15: Mean of overall rating by variety (n=48) during the organoleptic assessment. Error bar indicates minimum and maximum rating.

There was however no correlation between the attributes (figure 16) and the overall rating (figure 15). Only the attributes *fruity* and *buttery taste* were correlation to variety preference, with rates of 0.54 and 0.52, respectively. La Victoire was named as favourite variety by 5 out of 10 participants and as second favourite variety by 2 participants. Slenderwax was the favourite variety of 3 out of 10 participants, and the second favourite variety for one participant.



Figure 16: Sensory chart of the two selected bean varieties for the upcoming trials of T5.2. The grey area shows the range of values obtained by the variety for each attributed

While there was a clear preference from the tasters to certain varieties over other, we came to the conclusion that like for broccoli, an organoleptic testing of bean is not a necessity for the selection of varieties. Moreover, and specifically for beans, other traits such as the colour of the pods can differentiate one variety from the other and play a role in the selection.

To conclude, the two varieties "La Victoire" and "Slenderwax" performed the best overall. These varieties will be therefore used in all bean on-farm trials of T5.2. The seeds of these two varieties are multiplied by P18-ITAKA.

4.4 Selection of additional genetic material per location

Following P6-FiBL's instructions, T5.2 partners selected additional material to cultivate on their onfarm location in addition to the common varieties. In section 3.4.1 to 3.4.3, we list for each crop the all varieties included in each partner's trial with the reason behind their selection. These lists of varieties are valid for the first year trial and might be substituted in the second year depending on the results and especially whenever breeding lines from BRESOV with enough seed quantities are available.

4.4.1 Broccoli material per partner location

Partners	Broccoli	Selection criteria
All listed partners	Rasmus	
(except ZAAS, BAAFS)	CN-BRO-09	Results trials T5.1
	Marathon	Marathon is CMS free variety reference and was selected by consumers on tastings jointly with other two varieties (Malibu and Parthenon). A traditional cultivar well adapted to a wide soil and environmental conditions
P4-UTAD	Naxos	Variety widely cultivated in Portugal for 2 growing seasons
	Heraklion	Variety with good re-emission after cutting the main head, which is appreciated by organic broccoli producers.
P5-VURV	Limba	Czech cultivar, suitable for local conditions according to genebank information and also suggested by Moravoseed seed company
	Ironman F1*	Ironman F1 is a CMS standard reference variety.
	Batavia F1	Batavia F1 is a non-CMS standard reference variety .
P6-FiBL	Sat 30	Sat 30 was evaluated as very good in previous trials of other projects and was among the top varieties in the Italian trial of T5.1.
	KSV-Bro-CHE- Balb	KSV-Bro-CHE-Balb gave very good results in both Italian and Swiss trials of T5.1.
P9-UNILIV	Calabrese Waltham (VOG146)	Waltham has been grown at a farm local to the partner and is oganically produced. It is ppen pollinated, has GB-ORG-05 and Soil Association Organic symbol, EU rules and standard seeds ref:355.
	Calabrese	Calabrese is a common standard variety used by VRDS as reference (control variety) in their trials.
P11-VRDS	Broccolo Nero UNICT line 4939 BR 354 or 4479 BR 137 R	These are 2 lines of landraces originating from UNICT's tests, are among the elite breeding lines and have enough seeds available for an on-farm trial. These can be optionally added conditional to receiving the seeds on time.

*at FiBL the CMS-variety Ironman F1 had to be replaced by the non-CMS Covina F1 on planting day. It was not possible to prepare the seedling Ironman at the same organic nursery. It was grown on station and got infected with lice. The treatment applied provoked a phytotoxic reaction burning the leaves. It had to be replaced by whatever seedlings were available at an organic nursery.

Partners	Broccoli	Selection criteria (continued)
		Most commercial production in Siciliy use F1 from
		CMS for their early maturity, homogeneity and good
	Navos E1	production. Naxos is currently often replacing
PIO-ITANA	INDXUS F1	Marathon F1 and Pacman F1 due to ist higher
		resilience against climatic changes. This will be used
		as the control reference.
		Steel F1 is a CMS-free broccoli hybrid used as
P21-SECL	Steel F1 (Seminis)	standard variety in organic broccoli production
		locally.
	BAAFS own test	
FIS-DAATS	lines	
		An excellent F1 CMS (cytoplasmic male sterility)
	ZQ75	variety selected through multi-point common
		cultivation. Has round shape curd and dark green
		color.
		An excellent F1 CMS (cytoplasmic male sterility)
P14-ZAAS	7080	variety selected through multi-point common
	2000	cultivation. Has round shape curd and dark green
		color.
		F1, CMS commercial control variety originating from
	Emerald Crown	Japan and popular in China where it is widely
		cultivated.

4.4.2 Tomato material per partner location

Partners	Tomato OF	Tomato GH	Selection criteria
All listed partners	FiBL8_To65_Mauro Rosso	FiBL2-298X	Results trials T5.1 for GH tomato and all 4 available
All listed partners	FiBL9_Sativa Industrie 2 (PVB8)	FiBL7-TZ24	OF tomato.
	FiBL10_Sativa Industrie 3 (PVB67)	FiBL3-236X	
ZAAS, BAAFS)	FiBL 12_ PL-10 Bacau	FiBL4-TZ32	
		Rugantino RZ F1	Rugantino is a F1 reference for Coeur de Boeuf.
P6-FiBL		Annamay F1 (Enza	Annamay is a F1 reference for this calibre of salad
		Vitalis)	tomato.
	Ace Royal		Control varieties from P11 own selection used in T5.1
	Buzau 47		trials.
	PL_Buzau 4		Control local population from P11 own selection. All
P11-VRDS	PL_Leana mare		materials form P11 own selection were the subject of
	PL_Inima de bou		T5.1 investigations carried at VRDS. The selection
	PL_Mare		criteria included earliness, suitability to organic
	PL 15		cultivation (resistance to biotic stress), productivity
			It is characterized by higher total yield and number of
	HF1 17-1061		fruits per truss. It was well accepted by panel test
			(T5.1) in particular for tasting.
			It was well accepted by panel test (T5.1) both for
	Malareto		taste and aroma. Furthermore it is characterized by
P12-CREA			good yield and fruits quality.
			It was the most preferred accession by panel test
			(T5.1), either for tasting or for visual aspect.
	Cream sausage		Furthernore it has good productivity, high Brix, and
			low expression of Sola I 4 allergen tested by Real time
			PCR.
			Pizzutello is an indeterminate tomato variety which is
			cultivated both on the field and under greenhouses in
			Sicily and has under both systems a good production.
			It is well adapted to Sicily, highly resistant to parasites
	Pizzutello	Pizzutello	and disease, and does not require particular care and
			attention. This variety is very appreciated by
P18-ITAKA			customers, has small fruits and is therefore a good
			referene for the salad tomato type lines in the GH
			test.
			Tomato variety originally from America and cultivated
		Delasente	mainly in Calabria south of Italy . It has large fruits of
		Belmonte	the beef type (Cuore di bue) is pink and turns red
			when fully ripe.
			"Codino" (Enza - Vitalis) is a new variety selected in
			2018 at SECL, resistant to Cladosporium, to replace
P21-SECL		Codino	"Graziano" (Enza-Vitalis) which was the standard but
			is newly becoming susceptible to cladosporium.
		BAAFS own test	
P13-BAAFS		lines	
			An Excellent variety selected through multi-point
		∠F702	common cultivation by ZAAS
		75711	An Excellent variety selected through multi-point
D14 7446		∠⊦711	common cultivation by ZAAS
P14-ZAAS		75710	An Excellent variety selected through multi-point
		∠⊦712	common cultivation by ZAAS
		75202	Control variety which is grown in large areas in China.
		2F2U2	

Remark: P18-ITAKA – subsequently and after the OF variety trial – changed the reference for tomato for Tiepolo F1 instead of Pizzutello or Belmonte.

4.4.3 Bean material per partner location

Partners	Beans	Selection criteria			
All listed partners (except ZAAS.	Slenderwax	Results trials T5.1			
BAAFS)	La Victoire				
	Maxi	Reference variety. Described as very early and productive variety. The fruiting above the foliage facilitates harvesting. Ideal for early and late sowing under cover or in the field.			
	Schwaze*	Reference variety especially adapted for the use as corn beans (use of the seeds without the pods)			
	Jacob's Cattle*	Very old variety of dry bean, which also matures in cooler climates. Suitable as dry bean for soups and stews. When young, the pods can also be harvested green and prepared. Very popular in north America today. PSR selection.	*In this trial, we supplement the 2 test varieties and the reference with up to 5 other bean varieties, for which we see primary some potential in the corn bean production. These varieties		
P6-FiBL	Red Valentine*	It is precocious, well suited as a dry bean but because of its tenderness it is mainly used as a green bean. Wide spacing recommended. PSR selection.	(except for Schwarze) has been gathered by PSR and from their descriptions we deem these varieties also feasible for a snap bean use, if only		
	Brown Swiss* or Ece033	The bush bean can be used as a green or dry bean. PSR selection. Can be substituted with Ece033 breeding line resulting from P16-SERIDA's tests, if enough seeds are available.	performance of each single variety, but presumably also let us experience the range of varieties in these two very different uses, and how bie the trade off might be among several factors.		
Enfant de Mont Calme* or Prenel		It is one of the very rare Swiss bean varieties. It is a robust variety with fleshy, fairly straight pods and white seeds. Could have potential for both uses. PSR selection. Can be substituted with "Prenel" variety resulting from P16-SERIDA's tests, if enough seeds available.	(e.g. agronomic perfomance vs. quality of a snap bean product vs. quality of a dry bean product).		
	SBP-240_Prennel	Suggested by P16-SERIDA after trials of WP3 which showed a resistance to Oidium, an intermediate reaction to white mold and a very good response to organic cultivation on the field.			
	SBP-091_Ec033	Suggested by P16-SERIDA after trials of WP3 which showed an intermediate reaction to Oidium, an intermediate reaction to white mold and a good response to organic cultivation on the field.			
	SBP-033_Golden Teepee	Suggested by P16-SERIDA after trials of WP3 which showed an intermediate reaction to Oidium, an intermediate reaction to white mold and a good response to organic cultivation on the field.			
	Perlata	Control variety from P11 selection.	All the material form P11 own selection were in		
PII-VRDS	Salvica	Control variety from P11 selection	VRDS T5.1 investigations. The selection criteria		
	L9_line	Control line from P11 selection	(resistance to biotic stress) productivity,		
	Lechinta	Control variety from P11 own selection	P11-VRDS will perform T5.2 trials on 2 locations:		
	L 18_line	Control line from P11 selection	the experimental farm on station and a second location on-farm. Because of the limitation in seed		
	L 52_line	Control line from P11 selection	number for some varities, not all can be tested in both locations. Therefore, the list of VRDS lines		
	PL Regina pietei	Control local population from P11 selection	"P11 selection" was included here, knowing that		
	loana	Control variety from P11 selection	only some of these will be included, in one or the		
	Miruna	Control variety from P11 selection	other of the 2 locations.		

Partners	Beans	Selection criteria (continued)			
	SBP-240_Prennel	Suggested by P16-SERIDA after trials of WP3 which showed a resistance to Oidium, an intermediate reaction to white mold and a very good response to organic cultivation on the field.			
	SBP-091_Ec033	Suggested by P16-SERIDA after trials of WP3 which showed an intermediate reaction to Oidium, an intermediate reaction to white mold and a good response to organic cultivation on the field.			
	SBP-033_Golden Teepee	Suggested by P16-SERIDA after trials of WP3 which showed an intermediate reaction to Oidium, an intermediate reaction to white mold and a good response to organic cultivation on the field.			
	Manteca de los mecado	It is a local speciality and acts as a standard reference in the trial.			
	Contender	Standard variety used locally, acts as a reference in the trial.			
	163 SBP_163				
P16-SERIDA	49 SBP_049				
-	73 SBP_073				
	237 SBP_237				
	58 SBP_058				
	240 SBP_240	Selection of 12 lines made by P16-SERIDA based on incidence of pests and diseases, pod production per			
	211 SBP_211	plant and pod phenotype as obtaines in their other			
	303 SBP_303	trials of BRESOV. Out of this list 5 to 8 lines will be included in the on-farm trial.			
	36 SBP_036				
	15 SBP_015				
	30 SBP_030				
	217 SBP_217				
	320 SBP_320				
P18-ITAKA	Ferrari (Furia seeds)	It is an early , uniform type adapted to mecanical harvest.			
	Maxi	Maxi is a good standard bean reference for the region and is easy to harvest.			
P21-SECL	Coco de Paimpol	Coco de Paimpol is a variety specific to this region (brittany) and is their bean speciality. It is not used as snap (french) bean, the dried seeds are used.			
	C08	The excellent line selected from common planting had good comprehensive resistance and high yield			
P14-ZAAS	C17	The excellent line selected from common planting			
	C29	The excellent line selected from common planting			
	ZY3	Control variety which was popular in China			

In Brittany, organic cultivation of beans is only allowed with seeds guaranteed free from bacterial blight *Pseudomonas savastanoi pv. phaseolicola, Xanthomonas citri pv. fuscans* and *Xanthomonas phaseoli pv. phaseoli.* If the multiplication of beans results in more seeds than needed and in quantities sufficient for a phytosanitary test (i.e. 5000 seeds per lot ad test are required), tests will be carried. If this is not possible and as a plan B, P21-SECL will test La Victioire and Slenderwax (currently out of stock) purchased from a seed producer.

4.5 Crop cultivation conditions at each location

Eleven partners are performing on-farm trials within T5.2. All except P13-BAAFS and P14-ZAAS will be including among other material, the common lines and varieties selected as described in sections 3.1 to 3.3. Listed in table 6 are the crops included in each partner's on-farm variety trial(s) as well as the location of the farm. P11-VRDS and P12-CREA are performing trials on two locations each. Recently, P18-ITAKA suggested to perform trials additionally in a second location as well (not listed in table 6). The cultivation of broccoli, tomato and bean sometimes differ between the locations. In tables 7, 8 and 9, partners report the usual characteristics of their cultivation, as it was known to them at the beginning of the project. These tables give an indication in terms of timing, cultivation maintenance and protection. The actual trials on-farm may in some cases slightly differ from the partner indication in these tables, in order to enable farmers to follow their own usual production method.

	Tomato	OF/GH	Broccoli	Bean	Location
P4-UTAD			2		Biobrassica, Braga, Portugal (41.537848,-8.399278)
P5-VURV			2		Pustějov 65, Czech Republic (49.7001928N, 18.0076361E)
P6-FiBL	Č	GH	2	and the	Orto Loco Genossenschaft Spreitenbacherstrasse 35, 8953 Dietikon, Switzerland (47.409941, 8.382459)
P9-UNILIV			22		field of Molyneux Kale Company Ltd, Cut Lane, Scarisbrick, L408JU (53.579418, -2.924521)
P11-VRDS	۲	OF	2	-	2 locations: on-farm (Judetul Bacau Comuna Beresti - Bistrita Cod Siruta - 21249, Nr Bloc Fizic - 1478, Nr Parcela agricola -15) (46.713265, 26.865477), on certified campus farm VRDS Bacau, Romania (46.584785, 26.951090)
P12-CREA	*	OF			2 locations: Farm n°1: Az. Agricola Concetti Giuliana, C.da S. Anna, cap 63076 Monteprandone (AP) (42.897600, 13.835978) Farm n°2: Az. Agricola Roberto Battaglia, Via Fonte Maione n.1, cap 64028 Roseto Degli Abruzzi (TE) (42.711976, 13.963515)
P13-BAAFS		GH	_~~?		Machangying village,Pinggu District,Beijing
P14-ZAAS	1	GH	22	Alex	Zhejiang Lvye Eco-agriculture Ltd (30°55′17″N , 120°15′42″E)(30.921389, 120.261667)
P16-SERIDA				and the	organic farm cooperative at 21m altitude at Cuevas, La Huertona, Ribadesella (43.453371, - 5.070714) , CADAE, Asturias
P18-ITAKA	(GH	2	and the	Micieli Guiseppe C/da Randello, 97100 Ragusa (36.818527, 14.462475)
P21-SECL	(GH	2	and the	On-station organic farm at Terre d'essais, SECL (48.806106, -3.150463)

Table 6: Crops cultivated on-farm by each partner, and the location of the farm. GH is for greenhouse or tunnel tomato, while OF is for open field tomato cultivation.

Broccoli	P4-UTAD	P5-VURV	P6-FiBL	P9-UNILIV	P11-VRDS	P13-BAAFS	P14-ZAAS	P18-ITAKA	P21-SECL
Cultivation period									
Sowing	Spring and Summer	March-April	End January - begin. February	April - May	May	January-Feburary, June-July	Spring, Dec to Jan; Autumn, Aug	November	1)starting February in GH , 2) July-August
Sowing in pots or without transplanting	Sowing in pots	transplanting	transplanting	transplanting from trays		Sowing in pots and transplanting	Sowing in pots and need transplanting	transplanted	
If so, timepoint of transplantation to field	March	April	beginning April	beginning April		March, July	Spring, Feb; Autumn, Sep	December	
Harvesting (timepoint or period)	May - June	June - July	June - July	June - July	September - October	May-June,September- October	Spring, Apr; Autumn, Nov	mid March	1) June, 2) October
Total cultivation time	3 - 4 month	80 days from planting	80 days from planting	80 days from planting		Spring ca. 150 days;Autumn ca. 120 days	Spring, about 120d; Autumn, about 90d.		1)april to june/july, risky and 2)early August to Oct-Nov
Market for tomato: fresh vs. Industry			fresh	fresh					
Harvesting method (for beans)							By hands		
Example of local variety		Vitamina	Covina, Batavia			Yanxiu, Naihanyouxiu (Sakata)	Yanxiu, Naihanyouxiu (Sakata varieties)	Marathon (Sakata/Esasem)	Chevalier in spring, Steel and Ironman in autumn
Production system									
Glasshous/tunnel/field	Open field	Open field	Open field	Open field	Open field	Open field	Tunnel	Greenhouse+net	Open field
Crop density (plants/m ²)		9 pl/m2	3.3-4 pl/m2		ca. 4 pl/m ²	4 pl/m2	ca. 3.3 pl/m2		2.8 pl/m2
Plant spacing (within rows, in between rows)	40 cm x 60 cm	50 X 50 cm	50 X50 to 40x70 (can varry)	60 cm between rows/ 40 cm between plants	35 cm within rows	50 X 50 cm	35-40cm X 65-70cm, sometimes 40 & 80 cm	50 X 50 cm	40 * 90 cm
Cultivation type (e.g. in rows, plant stem stabilisation e.g. with ropes or sticks,)	Rows	in row	in row	in row		in rows	in rows	in rows	In rows
Pollination (by hand/by insect)	Insect			NA				natural	natural
Soil preparation		mechanical	rototiller	rototiller				rip	
Plant handling									
Watering regime	Furrow irrigation		sprinkler if needed	Rain fed		drip irrigation		drip irrigation	
Nutrient management	Green manure, composting	manure				green manure		manure	Green manure + Compost
Weed management (manually, mechanically)	Manually	manually		Manual		manual		manual	Mechanically (organic farming)
Pest management (based on local regulations for organic farming?, biocontrol, etc.)	Based on local regulations for organic farming		following pest or disease incidence according to the intrant list of FiBL: https://shop.fibl.org/c hde/mwdownloads/d ownload/link/id/52/	predator net	Bordeau mixture, Sulfur, Neem, pyrethrine for strong attack of Phyllotretra, bt against Pieris, asociation with tomatoes, sowing hemp in broccoli fields, distribution of freshly harvested tomato shoots on the field.	organic		organic	If needed: Cover, Spinosad
Frequent pests or diseases	Cabbage caterpillar	Pieris brassicaceae		Pigeon/ DBM/ Cabbage white	Peronospora parasitica Alternaria brassicicola Albugo candida, Plasmodiophora brassicae, Botrytis cinerea, Phyllotretra nemorum, Pieris brassicae	Moth,black spot, black rot	black spot, black rot, root rot	Moth, Plasmodiophora brassicae, Phoma spp, Bacteriosis (Xanthomonas and Erwinia), Botritis.	Bird, catterpilar

Table 7: Broccoli cultivation at partners' locations.

Tomato	P6-FiBL	P11-VRDS	P12-CREA	P13-BAAFS	P14-ZAAS	P18-ITAKA	P21-SECL
Cultivation period							
Sowing	Beginning of March	March	Beginning of March	January-Feburary,June- July	Spring, Jan to Feb; Autumn, Jul	March// Alt: April or August-Sept	Jan-February
Sowing in pots or without transplanting	plate then pots after 1- 2w, transplanting 8W later	transplanted	transplanted	Sowing in pots and transplanting	Sowing in pots and need transplanting	transplanted	transplanting
If so, timepoint of transplantation to field	Mid-April-Beginning of May (approx 9 weeks post sowing)		Мау	March,July	Spring, Mar; Autumn, Aug	April	March
Harvesting (timepoint or period)	June-July to September	August - October	July to August	June-July,September- October	Spring, May-Jul; Autumn, Oct-Dec	July	sept-Oct
Total cultivation time	5 Months (May to Sept)		5 months (April to August)	Spring about 150 days;Autumn about 120 days	Spring, about 150d; Autumn, about120d.		7 month
Market for tomato: fresh vs. Industry	fresh	Fresh and industry	Fresh				
Example of local variety			Italian landraces	Qidali(Syngenta),7845 (Seminis),Luola(Hazela), Qiusheng(Jingpeng),Qian xi (Knownyou),Xiarihong (Xinhua),Xiariyangguang (Hazela)	Zhefeng202, Zhefeng 706, Zheza 203, Zheza 503 (ZAAS varieties)	Tomato red bunch: Larimar (Vilmorin)	Graziano
Production system							
Glasshous/tunnel/field	Polytunnel	open field	open field	tunnel	tunnel	Greenhouse+net	plastic green house (frost free heating)
Crop density (plants/m ²)	2.5 pl/m2	ca. 4.7 pl/m ²	2.0 pl/m2	5 pl/m2	2.7 pl/m2		2.5 pl/m2
Plant spacing (within rows, in between rows)	50 cm and 1.20/0.80m, respectively	30 cm within rows	(0,7 m x 0,6 m) x 0,9 m	33-45cm X 70-75cm	40-45cm X 80-120 cm		50 - 80 cm
Cultivation type (e.g. in rows, plant stem stabilisation e.g. with ropes or sticks,)	rows, with rope		rows with sticks	in rows, plant stem stabilization with ropes or sticks	in rows, plant stem stabilization with ropes or sticks		trainning on string
Pollination (by hand/by insect)	wind - no action taken		free pollination				bumble bees
Soil preparation	rotor tiller		plowing at 25-30 cm				spade machine

Table 8: Tomato cultivation at partners' locations.

Tomato	P6-FiBL	P11-VRDS	P12-CREA	P13-BAAFS	P14-ZAAS	P18-ITAKA	P21-SECL
Plant handling							
Watering regime	drop irrigation as needed		drop irrigation as needed	drip irrigation		drip irrigation	
Nutrient management	fertigation		animal pelleted, fertigation	green manure		manure+liquid	compost + manure + organic manure : DCM Eco Mix (7.3.12)
Weed management	plastic mulch + manually if needed		plastic mulch	manual		manual	manually + plastic film
Pest management (based on local regulations for organic farming?, biocontrol, etc.)	following pest or disease incidence according to the intrant list of FiBL: https://shop.fibl.org/chd e/mwdownloads/downlo ad/link/id/52/	Urtica dioica macerates or Symphytum officinale, Bordeaux mixtures, favorable crop associations, traps against criquets	organic	organic		organic	biocontrol and possibly Sulfur
Frequent pests or diseases	white fly, aphids	Phytophthora infestans, 2. Grilotalpa grilotalpa	phytophthora inphestans	TYLCV, TMV, ToMV, bacterial wilt, gray leaf spot disease, grey mold, Phytophthora, Fusarium wilt	TYLCV, TMV, ToMV, bacterial wilt, gray leaf spot disease, grey mold, Phytophthora, Fusarium wilt	Virus (TYLCV), Nematodes, Peronospora, Botritis, Fusarium,Tuta absoluta	aphids, whitefly, powdery mildew, botrytis

Table 8 (continued): Tomato cultivation at partners' locations.

Partner	P6-FiBL	P11-VRDS	P14-ZAAS	P16-SERIDA	P18-ITAKA	P21-SECL
Cultivation period						
Sowing	June-July	May	Spring, Apr -June; Autumn, Aug	May to mid June sowing in pots and plantign	July	June
Sowing in pots or without transplanting	direct sowing		without transplanting	transplanting		
If so, timepoint of transplantation to field				End may, beginning June		
Harvesting (timepoint or period)	begin. September	August - September	Spring, May; Autumn, Sep	end july, beginning august (green pods)	October	October
Total cultivation time	60-70 days		Spring, about 90d; Autumn, about 70d.	60-70 d (green pod) 90-110 d (dry) - from planting (not sowing) to harvesting		
Market: fresh vs. Industry	fresh	fresh market				
Harvesting method (for beans)	machine	machine	manual	manual		manual for fresh market
Local variety			Zheyun series (ZAAS varieties)	Indeterminate (Musica, Garrafal Oro, Buenos aires, maravilla de Venecia,) Determinate (manteca rocquencourt, contender, manteca de los mercados, midas,)	French beans: Xera (Seminis)	Coco de Paimpol
Production system						
Glasshous/tunnel/field	open field	open field	tunnel	open field	greenhouse+net	open field
Crop density (plants/m ²)	30-35 pl/m2 (25-30 also ok)	ca.15 pl/m ²	ca. 3.3 pl/m2	10 pl/m2		10 pl/m2
Plant spacing (within rows, in between rows)	40-45 cm	10 cm within rows	distance within rows, 40cm; distance between rows, 70cm.	20 cm x 150 cm (two rows 20cm separated, then 150m distance to next)		14*75
Cultivation type (e.g. in rows, plant stem stabilisation e.g. with ropes or sticks,)	in row		in rows, plant stem stabilization with ropes or sticks			In rows
Plant handling						
Watering regime				without irrigation	drip irrigation	
Nutrient management (e.g. green manure,)	none			organic material (BIOREX) +	manure+liquid	Green manure + Compost
Weed management (manually, mechanically)				plastic mulch + manually if needed	manual	Mechanically (organic farming)
Pest management (based on local regulations for organic farming?, biocontrol,)	following pest or disease incidence according to the intrant list of FiBL: https://shop.fibl.org/chd e/mwdownloads/downlo ad/link/id/52/	1-2 treatments with Bordeaux mixture 0,3-1% against fungi, urtica dioica macerates against aphids		biocontrol	organic	If needed: Cover, Spinosad
Frequent pests or diseases	botrytis cinerea, Sclerotinia sclerotiotum	Colletotrichum lindemuthianum, Xanthomonas campestris pv phaseoli,Acanthoscelides obtectus, Aphis fabae	rust	aphids, chinches, weevils	Nematodes, powdery mildew, rust, Bacteriosis, Antracnosis	seedling-fly, sclerotinia

Table 9: bean cultivation at partners' locations.

5 Deviations

Due to the outbreak of the Tomato Yellow Leaf Curl Virus in P18-ITAKA's tomato cultivation for the assessment and multiplication of GH and OF varieties, and with the culture time constraints, the assessment was based on P21-SECL's trial only. Therefore 4 GH varieties instead of 2 were selected and all 4 OF varieties available were included in T5.2 on-farm trials.

Seed quantity and availability being the limiting factor in these trials, and as shipment of seeds to China requires phytosanitary certificates which either cannot be produced or otherwise not in-time for their cultivation, it was decided that Chinese partners will conduct the trials in a similar manner but using a different local seed material.

6 Conclusions

We have successfully evaluated varieties of the 3 crops and will be providing farmers with new and diverse genetic material for broccoli, tomato and bean production and therefore meet the objectives of work package 5. The selection process brings new or little known varieties and breeding lines on multiple locations to be cultivated under regular local production conditions on-farm. At each location, this material will be compared to the local standards and lines selected for or adapted to each location. This experiment will allow us to tell the real potential of these lines and allow farmers to cultivate a diversity yet unknown to them and hopefully find varieties with desirable traits which they can use in the future. The final list of common varieties in test for each crop are listed and described in the annexed fact sheets below.

Annex: Fact sheets of selected material for their common evaluation in multiple on-farm locations.

RASMUS



Crown, green open pollinated (OP) variety. Very good performance in trials especially compared to most OP. FIBL4 Rasmus obtained a good yield, scored high on the production of first quality heads, with good shape comparable to F1 standards Covina and Batavia and short branches, as well as a low rate of rejected heads. Suitable for both spring and autumn cultivation. A very slight bitter note was sometimes detected.

CN-BRO-09



Crown, green open pollinated (OP) variety. Very good performance in trials especially compared to most OP, with the best production rate. Its shape and short branches are similar to F1 standards Covina and Batavia. Suitable for both spring and autumn cultivation. Variety found among the sweetest.

Tomato

Name & pictiure	Organoleptic	Agronomic
236-×	Preferred by consumers during a public degustation. They described it as sweet and acid and some mention it thick or hard skin. The trained panel characterized it as juicy, sweet, acid, with a lot of tomato flavour, a thick skin, an aromatic intensity and less mealy. It obtained the highest dry matter, Brix degree and titratable acidity.	Salad tomato selected in low-input condition. It has a special flavour and an expected (and partially know) tolerance to drought and reduced nutrient supply. Variety with fruits below 40 g, and with lower yield than bigger types. Its fruits are too large for the cherry type and are sensitive to bursting.
2 98-×	Appreciated by consumers but less than 236-X with mentions of hard or thick skin. According to the trained panel, it is crunchy, acid, thick skin, a little juicy and not very mealy. Its tomato flavour is rather intense. Its dry matter and brix degree and titratable acidity are close to those of 298-x although a little bit lower.	Salad tomato selected in low-input condition. It has a special flavour, field resistance against <i>Phytophthora infestans</i> , expected (and partially know) tolerance to drought and reduced nutrient supply. Variety with fruits below 40 g, and with lower yield than bigger types. 298 X produces a very nice set but its fruits are a little too big for the cherry type.
172 24	Appreciated by most consumers who described it as weak to mild in taste, slightly acid, fleshy and melting flesh. The panel however, detected a more pronounced tomato flavour, as the intensity of taste, it is sweet, low acid, slightly crisp, melty, and fine skin. However, its Brix degree, titratable acidity and dry matter are among the lowest.	Coeur de boeuf Pescarese, Oxheart /beafsteak type. It obtained a good yield in the test. TZ 24 has no special interesting features, is sensitive to BER (Blossom End Rot) and has yellow collars.
TZ-32	Received mixed rating from consumers who for some mention its mealy texture, firmness, lack of taste, and an atypical taste. According to trained panel, it is mealy, not juicy and has a thick skin. It is a little bit sweet and acid. Its Brix degree is close to that of TZ24 (4.6), its titratable acidity and its dry matter slightly higher (6.2 and 6%).	Coeur de boeuf Albenga pink, Oxheart /beafsteak type. Among the highest yielding varieties of the test. TZ 32 produces a very nice set with a beautiful brilliant colour, but nevertheless lacks firmness. This characteristic can make it sensitive to transport.



It was not presented to consumers. According to the trained panel, PL10 Bacau has a good tomato flavour, melty and a fairly thin skin. It has medium Brix degree (4.8), titratable acidity (7) and dry matter (5.9%).

Local population from Bacau. Determinate (60-75 cm plant height), suitable to open field, fresh market, and processing. Mosaic Virus & Alternaria were not observed on this population in Bacau. Has a yield around 60-80 t/ha and produces round fruits of average quality and medium weight (80-100 g).

Ps: the rest of the tomato varieties for open field cultivation have not been evaluated (please see deviation section 4).

Slenderwax Wax bean type with yellow pods and an elliptic round pod section. Rather low bush bean (55-60cm), with moderately good steadfastness (stability) compared to the other varieties in test. Good agronomic performance. In general, rather less susceptible to bacterial and fungal diseases, showed symptoms of bean mosaic virus in the trial. Good yield (1.6kg/m2) and good harvest performance (3.8 kg/h), which is probably also due to the good visibility of the yellow pods. Relatively uniform in shape and length of pods (13.5 - 15 cm) with average weigh (\emptyset weight: 4.94 g) but not very homogeneous in colour, ranging from light green to yellow. Pods are yellow when raw or cooked. It is rather unsuitable for one-time harvesting, as colour differs largely between young and ripe pods. Slenderwax was one of the two most popular varieties in the tasting although it appearance was rated as the least attractive during the tasting. It has a spicy odour, is very sweet and nutty compared to the other varieties. Slightly crunchy. . La Victoire Bush bean with green pods and an elliptic round pod section. It is a robust and early ripening variety of low to medium height (60-65 cm) and a good steadfastness compared to the other varieties. It was found little susceptible to diseases, obtained the best yield of the trial (1.6 kg/m2) and a quite good harvest performance (3.4 kg/h).Interesting variety for commercial cultivation with the agronomic performance in the trial. It has rather large and long pods (length: 12-15.5 cm) with relatively high fruit weight (Ø weight: 5.32 g). Relatively uniform in shape and colour, tending to bulbous pods not very attractive in appearance when overripe. Rather long harvest window, therefore less suitable for mechanical harvest. La Victoire was the most popular variety during tasting, favourite variety of 50% of tasters, and second favourite to 20%. It was found sweet, spicy and nutty in taste with a pronounced spicy smell compared to the other varieties and hardly fibrous beans.

Beans